Advances in activation of endodontic irrigants.

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Abstract

The final success of root canal treatment depends on complete debridement and disinfection of the root canal which is achieved by the use of appropriate irrigants and effective irrigation systems.

Root canal irrigation systems can be divided into two broad categories, i.e. manual agitation techniques and machine assisted agitation devices. Manual irrigation which includes positive pressure irrigation, is commonly performed using a syringe and a side vented needle. While machine-assisted irrigation techniques include sonic and ultrasonic and newer systems like apical negative pressure (ANP) irrigation.

This article summarizes the recent developments for the safe and effective irrigation which ultimately aid in to minimizing the bacterial levels resulting in successive endodontic therapy.

Key words: Root canal irrigants, endodontic therapy, rotary brushes, LASER.

Machine assisted irrigant delivery systems

Rotary brushes:

A rotary handpiece-attached to the microbrush was invented by Cliff Ruddle to facilitate debris and smear layer removal from instrumented root canal. The brush consist of a shaft or shank and a tapered brush section. During debridement phase, microbrush rotates at the speed of 300 rpm.[1]

It is not directly used for delivering an irrigant into the canal spaces. They are used as an adjunct that has been designed for debridement of the canal walls or agitation of root canal irrigant. Recently, a 30-gauge irrigation needle covered with a brush (NaviTip FX; Ultradent Products Inc, South Jordan, UT) was commercially available (Figure 1).

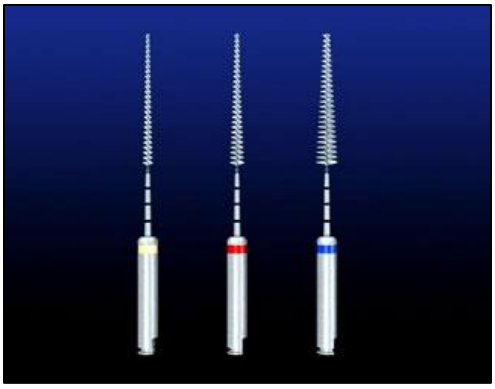

Figure 1: Endodontic microbrushes

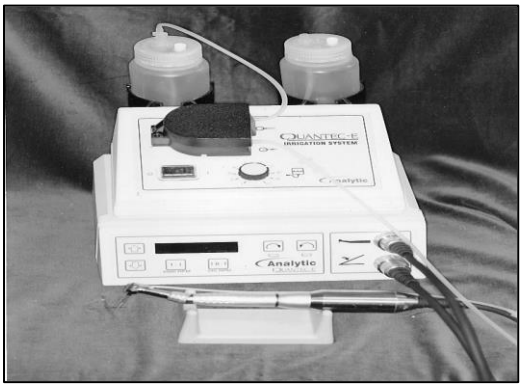

Figure 2: Quantec-E irrigation system

The Quantec-E irrigation system

The **Quantec-E irrigation system** (Sybron Endo, Orange, CA) is a self-contained fluid delivery unit which is attached to the Quantec-E Endo System (Figure 2). It consist of a pump console, two irrigation reservoirs, and tubing which provide continuous irrigation during rotary instrumentation.[2] Continuous irrigant agitation during active rotary instrumentation would result in generation of an increased volume of irrigant, increase irrigant contact time, and facilitate greater depth of irrigant penetration inside the root canal. This should result in more effective canal debridement in comparision with syringe needle irrigation.

Studies conducted by Setlock et al and Walters et al[3] concluded that Quantec - E irrigation did result in cleaner canal walls and more complete debris and smear layer removal in the coronal third of the canal walls.

SONIC IRRIGATION

Sonic instruments for endodontics were first reported by Tronstad et al in 1985. Sonic irrigation operates at a lower frequency (1–6 kHz) and produces smaller shear stresses than ultrasonic irrigation.[4]

The Vibringe system is the first endodontic sonic irrigation system that enables delivery and activation of the irrigation solution in the root canal, in only one step. The activation of the disinfectant with the aid of acoustic streaming enriches and completes the irrigation procedure and there by improves the success rate of endodontic treatments. It has been shown that this system drastically improves debridement. It also improvise the disruption of the smear layer and biofilm by activating irrigation solutions. It consist of a 2-piece syringe with a rechargeable battery. The irrigant is activated sonically, also the

needle that attaches to the syringe (Figure 3).

Rödig et al[5] studied that the efficacy of vibringe system they concluded that vibringe demonstrated significantly better results than syringe irrigation in the apical root canal third in removing debris.

Figure 3: Vibringe sonic irrigation system

The Endo Activator System is a more recently marketed sonically driven canal irrigation system. It consists of a portable hand piece and three different types of disposable polymer tips of different sizes (Figure 4). The Endo Activator can effectively clean debris from lateral canals, remove the smear layer, and dislodge clumps of biofilm within the curved canals of molar teeth, as they are smooth, they do not cut dentin.

Vibrating the tip, along with moving the tip up and down in short vertical strokes, synergistically results in a powerful hydrodynamic phenomenon. This can be operated 10,000 cycles per minute (cpm) shown to optimize debridement and promote disruption of the smearlayer and biofilm.[6]

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Figure 4: Endoactivator sonic system

Ultrasonics

Ultrasonic energy produces higher range of frequencies than sonic energy but low amplitudes, oscillating at frequencies of 25-30 kHz.[7]

It is more preferable to apply ultrasonics after completion of canal preparation rather than as analternative to conventional instrumentation.[8]

Studies on endosonic systems have evaluted that teeth prepared ultrasonically with UI devices have significantly cleaner canals than teeth prepared by conventional rootcanal filing alone. Other studies have also demonstrated the superiority of UI as a primary cleaning and shaping technique.

These results are because of the constraint of vibratory motion and cleaning efficacy of an ultrasonic file within the nonflared root canal space. Also, it is

difficult to control the cutting of dentin and hence the shape of the prepared root canal. Strip perforations as well as highly irregular-shaped canals were frequently formed. Therefore, it is more advantageous to apply ultrasonics after completion of canal preparation (Figure 5).

Figure 5: Ultrasonic irrigation system

Pressure Alternation Devices

The RinsEndo irrigation system and the EndoVac irrigation system are types of negative-pressure irrigation.

a. The RinsEndo system:

The RinsEndo system irrigates the canal by employing pressure suction technology developed by Durr Dental Co. It comprises of a handpiece, a cannula with a 7 mm exit aperture, and a syringe carrying irrigant. The handpiece is powered by a dental air compressor with an irrigation speed of 6.2 ml/min.[9] In this system, 65 ml of a rinsing solution oscillates at a frequency of 1.6 Hz is drawn from an attached syringe and transported to the root canal via an adapted cannula (Figure 6).

During the suction phase, the used solution and air are drawn outfrom the root canal and automatically mixed with fresh rinsing solution. The pressure Suction cycles change approximately at a rate of 100 times per minute[7].The manufacturer of Rins Endo claims that the apical third of the canal might be effectively rinsed, with the cannula restricted to the coronal third of the root canaldue to the pulsating nature of the fluid flow.

Figure 6: Rinse endo system

b. The EndoVac System:

The EndoVac apical negative pressure irrigation system has been lauched by Discus Dental Company. It has three principle components: The Master Delivery Tip, Macro Cannula and MicroCannula. The Master Delivery Tip concomitantly delivers and evacuates the irrigant solution. The Macro Cannulais utilized to suction irrigant

from the chamber to the coronal and middle segments of the canal. The Macro Cannula or Micro Cannula is attached via tubing to the high-speed suction of a dental unit. The Master Delivery Tip is connected to a syringe and the evacuation hood is connected via tubing to the high speed suction of a dental unit. The plastic macro cannula has a size 55 open end along with a .02 taper and is connected to a titanium handle for gross, initial flushing of the coronal part of the root canal. The size 32 stainless steel microcannula possess 4 sets of 3 laser-cut, laterally positioned, offset holes adjacent to its closed end. This is connected to a titanium finger-piece for irrigation of the apical part of the canal by placing it at the working length. The microcannula can be utilized in canals that are enlarged to size 35 or larger.

During irrigation, the delivery/evacuation tip carries irrigant to the pulp chamber and siphons off the surplus irrigant to prevent overflow. The cannula in the canal concomitantly exerts negative pressure that draws irrigant from its fresh supply in the chamber, down the canal to the tip of the cannula, into the cannula, and out through the suction hose. Thus, a constant flow of fresh irrigant is being delivered by negative pressure to working length.[10]

A recent study evaluated that the volume of irrigant delivered bythe EndoVac system was significantly higher than the volume delivered by conventional syringe needle irrigation during the same time period and use of the EndoVac system resulted in significantly more amount of debris removal at 1mm from the working length than needle irrigation.

Endovac Pure

Endovac Pure, a new irrigation system introduced by Kerr. It is the first system to leverage the apical negative pressure technique. It attaches a portable base unit with a sterile-packed cartridge and an ergonomically designed handheld controller for ease of use (Figure 7).

Endovac Pure's Apex cartridge is sterile packed and fully integrates the Macro Pure and Micro Pure cannulas for greater ease of use. The EndoVac system is intended for the delivery and evacuation of endodontic irrigation solutions during root canal procedures. On other hand EndoVacPure™ System is used for the delivery and evacuation of endodontic irrigation solutions as well as removing debris of injured or necrotic pulp tissue during root canal procedures.[6]

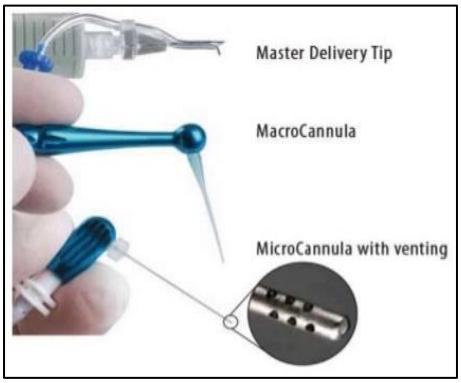

Figure 7: Endo vac system

Photo Activated Disinfection

Recently the concept of photo activated disinfection (PAD) in endodontic irrigation has been introduced, it minimize or eliminate residual bacteria in the root canal. A non-toxic dye, as photosensitizer (PS) and visible light with low intensity, in the existence of oxygen, is used in PAD technique, all this combine to produce cytotoxic species. The principle on which PAD works is that PS molecules get attached to the membrane of the bacteria.

Irradiation with light at a specific wavelength equivalent to the peak absorption capacity of the PS leads to the production of singlet oxygen, which leads to the bacterial cell wall to rupture, killing the bacteria.[11]

PAD is not only effective against bacteria, but also against other micro-organisms including viruses, fungi, and protozoa. FotoSan is the PAD device recently introduced by CMS Dental. The PS is a watery solution of toluidine blue O (TBO) that gets attached to the membranes of microorganisms and binds itself to the surface, then absorbs energy from the light and then releases this absorbed energy to oxygen (O2), which is transformed into highly reactive oxygen species (ROS), such as oxygen ions and radicals. According to manufacturer's protocol, after canal preparation, the canal have to be inoculated with the PS solution, which is left in situ for a fixed period of time (60 seconds) to allow the solution to come into contact the root canal and irradiation have to be carried out for a period of 30 seconds in each canal.

LASER

It has been well documented in numerous studies that CO2,Nd:YAG, Er:YAG, Er, Cr:YSGG laser irradiation has the ability to remove debris and smear layer from the root canal wall following biomechanical preparation (Figure 8). Numerous studies have found that Er:YAG is the most appropriate laser for intra canal debris and smear removal. Also various laser wavelengths have been used directly or as an adjunctive to disinfect canals. Laser light can penetrate areas of canals like secondary canals and deep dentinal tubules where irrigating and disinfecting solutions are difficult to reach, and also can

eliminate microorganisms from these areas.[12]

Figure 8: Laser irrigation

Ozone based Delivery System

Ozone is a triatomic molecule which consists of three oxygen atoms. It is applied to oral tissues in various forms like ozonated water, ozonated olive oil and oxygen/ozone gas. Ozone gas is unstable and readily dissociates back into oxygen (O2), thereby, liberating strong oxidizing agent, singlet oxygen (O1).This further impose the deleterious effect on microorganisms. Various delivery systems available for endodontic irrigation like Neo Ozone WaterS unit, Heal Ozone (Kavo) unit, the OzoTop unit (Figure 9). Nagayoshi et al found that ozonated water (0.5–4 mg/L) was very effective in killing both gram positive and negative microorganisms.[13]

Gram negative bacteria, like P.gingivalis, P.Endodontalis and Porphyromonas were substantially more sensitive to ozonated water compared to gram positive oral streptococci, C.albicans and few other species in pure culture. On observation, when the specimen was irrigated with sonication, ozonated water had nearly the same antimicrobial activity as 2.5%NaOCl. Ozone works best when there is less amount of organic debris remaining. Therefore, it is recommended to use either ozonated water or ozone gas at the end of the cleaning and shaping process. Ozone is effective when it is used in sufficient concentration, for an adequate amount of time. Ozone will not be effective if too little dose of ozone is delivered or it is not delivered appropriately.[14]

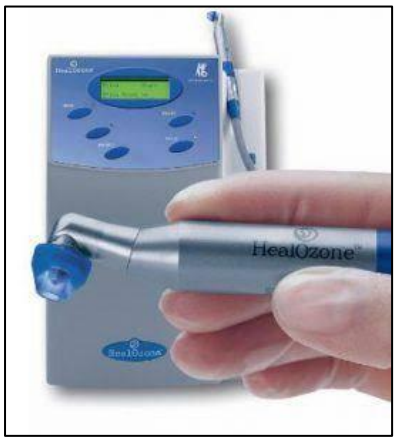

Figure 9: Ozone irrigation system

The VATEA system

The VATEA system is an irrigation device which is an integral part of Self Adjusting file rotary system (SAF). The VATEA system is a self-contained, fluid delivery unit. For use it is to be attached to dental handpieces to deliver irrigation during

endodontic treatment procedures. During the endodontic treatment, irrigating solution is pumped from the VATEA's 400 ml reservoir. The irrigant is delivered via a disposable silicone tube to the endodontic file. The flow of irrigant is toggled by a foot pedal. The flow rate can be adjusted by operator from 1-10 ml/min by using the -/+ push buttons located on the control panel (Figure 10). A recent independent study observed that in oval canals the SAF SYSTEM was found superior to rotary Ni-Ti files used with needle irrigation (NaOCl).

Figure 10: VATEA system

Conclusion

Variety of irrigation devices have been developed which provides effective cleaning and superior debris removal in order to replace the traditional needle irrigation method. Although, there is no high level of result that correlates the clinical efficacy of these devices with better treatment outcomes. Newer irrigation devices may change the insight of traditional endodontic treatment, due to the various safety factors, capacity of high volume of irrigant delivery and ease of application.

Financial support and sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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